Assessing Traffic Tolerance in Sports Turf Using Plant Growth Regulators

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ABSTRACT

Natural grass fields are vulnerable to traffic-induced damage, prompting increased reliance on synthetic turf despite its environmental and safety concerns. This study evaluates the effects of three plant growth regulators (PGRs)—Gibberellic Acid (GA_3), Paclobutrazol (PBZ), and Trinexapac-ethyl (TE)—on the traffic tolerance of cool-season turfgrass species. GA_3 stimulates shoot elongation, whereas PBZ and TE inhibit gibberellin biosynthesis, reducing vertical growth and potentially enhancing stress resilience (Beasley et al., 2005). Sports turf species are currently being assessed under five weeks of simulated traffic, with measurements of Normalized Difference Vegetation Index (NDVI), Excess Green, Surface Hardness, and Shear Strength. Preliminary trends indicate treatment-specific differences in visual quality and mechanical performance. This research aims to determine whether PGR applications can improve natural turf durability and support more sustainable sports field management.

Objective

Assess how gibberellin-targeting PGRs (GA_3, PBZ, TE) influence traffic tolerance and recovery in cool-season turfgrasses under simulated wear.

Experiment Workflow

Sod Installation → PGRs Application → Traffic Application → PGRs Application

MATERIAL AND METHODS

Experimental Design: Split-plot RCBD with three replications.

- Main plots: Traffic (Yes/No)
- Sub-plots: PGR treatments

Turf species (sod): Kentucky Blue Grass (KBG), blend of KBG and Perennial Ryegrass (PR), and Tall Fescue (TF)

PGRs Application: Applied before and after traffic simulation:

A) GA_3: 0.5 oz/acre B) PBZ: 16 oz/acre C) TE: 11 oz/acre

Traffic Simulation: Simulated 15 football games over 5 weeks using a mechanical traffic simulator **"Cady"** (Henderson et al., 2005).

Measurements:

- NDVI: Reflects plant vigor (higher = healthier)
- Excess Green (ExG): Image-based greenness index (higher = greener)
- Surface Hardness: Measured via 2.25 kg Clegg Hammer (higher = firmer)
- Shear Strength: Measured with Shear Vane Tester (higher = better footing)

Future Statistical Analysis: ANOVA with Tukey's HSD ($p < 0.05$) in R (4.4.1) using the package agricolae.

DISCUSSIONS

- NDVI and greenness declined under traffic, indicating reduced turf vigor across all species.
- GA_3 appeared to maintain higher greenness, especially in KBG/PR, suggesting better visual recovery.
- PBZ and TE showed lower greenness, possibly due to growth suppression that may favor structural resilience.
- Surface hardness increased with traffic, particularly in KBG; elevated hardness (>80 G_{max}) may raise injury risk (Villanueva et al., 2024).
- KBG/PR and TF maintained softer surfaces, potentially improving safety.
- Shear strength decreased under wear, but KBG and KBG/PR retained higher values, which may support better footing.

FUTURE RESEARCH

Future studies should assess the long-term effects of repeated PGR applications over multiple growing seasons to optimize turfgrass recovery, improve wear resilience, and minimize dependence on synthetic surfaces and chemical inputs.

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RESULTS AND DISCUSSION

TURFGRASS GREENNESS AND VIGOR RESPONSE TO TRAFFIC AND PGR TREATMENTS

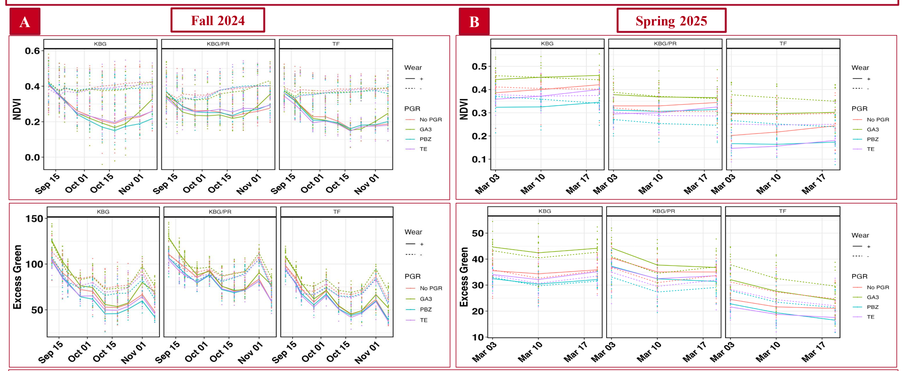

Figure 1. A–B. NDVI (top) and Excess Green (bottom) trends for KBG, KBG/PR, and TF under different PGRs and traffic treatments during Fall 2024 (A) and Spring 2025 (B). GA_3-treated plots generally maintained higher greenness and vigor, especially under wear stress. Data derived from drone-based digital image analysis. Solid lines = traffic; dotted lines = no traffic.

EFFECT OF TRAFFIC ON SURFACE PLAYABILITY IN FALL-2024

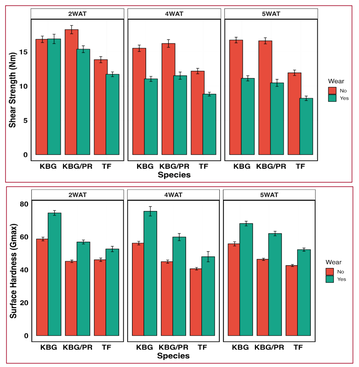

Figure 2- Shear strength (Nm) and surface hardness (G_{max}) of KBG, KBG/PR, and TF under wear (green) and no-wear (red) conditions at 2, 4, and 5 weeks after traffic (WAT). Error bars indicate standard error of the mean (SEM).